Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Veterinary Medicine and Animal Science

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En rapport om följsamheten till hygienrutiner på en svensk idisslarklinik – En observationsstudie

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Summary

Adhering to infection control routines in veterinary clinics plays a vital role in stopping the spread of communicable diseases and reducing the likelihood of the spread of antibiotic resistance. There are many simple steps, including disinfecting hands and wearing protective aprons and gloves, which one can take to protect oneself, one's patients, and one's community from dangerous pathogens. The aim of this study is to assess the level of compliance with basic infection control routines in a Swedish ruminant clinic.

In order to examine the compliance levels, an observational study was conducted at the Ruminant Medicine and Veterinary Epidemiology Clinic in Uppsala, Sweden. The study included staff members, students, and visitors. The study also set out to note miscellaneous areas of the clinic that may need improvement.

The results showed that there is progress to be made when it comes to compliance with basic infection control routines, including hand disinfection, glove use, protective apron use, having hair up/short, shoe changes, boot cleaning, and having forearms free from jewellery. The observations assessed the routines when entering and exiting both the clinic and examination rooms. Noteworthy findings included that only 24% of the staff, 41% of the veterinary nursing students, 23% of the clinic's veterinary students, 57% of other veterinary students, and 10% of the visitors disinfected their hands when entering the clinic, giving an average compliance of 31% for this routine. In addition, there were many areas of the clinic that could use improvement, including the cleaning and disinfection of common areas and shoes provided for students and visitors, and the layout of the infection control barriers.

More encompassing studies would need to be made in order to provide solutions to the lack of compliance, for instance educational interventions and incentives, but this study is an important step for the clinic in improving its adherence to infection control protocols.

Keywords: infection control, health care-associated infections, compliance, ruminant clinic, hygiene

Sammanfattning

Att följa hygienrutiner på veterinärkliniker är en viktig del i att förhindra spridningen av smittsamma sjukdomar och minska sannolikheten för spridning av antibiotikaresistens. Det finns många enkla åtgärder, bland annat att desinficera händerna och ha skyddsförkläden och handskar, som en kan använda för att skydda sig själv, sina patienter, och samhället från farliga patogener. Syftet med denna studie är att bedöma nivån av följsamhet till basala hygienrutiner på en svensk idisslarklinik.

För att undersöka denna följsamhet genomfördes en observationsstudie vid Institutionen för idisslarmedicin och epidemiologi (IME-kliniken) i Uppsala, Sverige. Studien omfattade personal, studenter, och besökare. I samband med studien gjordes dessutom ett försök att uppmärksamma olika delar av kliniken som kan behöva förbättras.

Resultaten visade att förbättringar bör göras när det gäller följsamhet till basala hygienrutiner, inklusive handdesinfektion, handskanvändning, skyddsförkläde, att ha håret uppsatt/kort, skobyten, stövelrengöring, och att ha armarna fria från smycken. Observationerna bedömde rutinerna när individer gick in och lämnade både kliniken och undersökningsrummen. Ett anmärkningsvärt resultat var att endast 24% av personalen, 41% av djursjukskötarstudenterna, 23% av klinikens veterinärstudenter, 57% av övriga veterinärstudenter och 10% av besökarna desinficerade händerna när de gick in till kliniken, vilket innebar en genomsnittlig följsamhet på 31% för denna rutin. Dessutom fanns det många delar av kliniken som skulle kunna förbättras, inklusive rengöringen av gemensamma utrymmen och skor som tillhandahålls för studenter och besökare, samt utformningen av hygienslussarna.

Mer omfattande studier skulle behöva göras för att hitta lösningar till bristen på följsamhet, exempelvis utbildningsinterventioner och incitament, men denna studie är ett viktigt steg i klinikens mål att förbättra följsamheten till hygienrutiner.

Nyckelord: hygienrutiner, vårdrelaterade infektioner, följsamhet, idisslarklinik, hygien

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1 Introduction

1.1 Background

Having adequate infection control routines is an important part of stopping the spread of communicable diseases and antibiotic resistance. It is important to follow infection control protocols for the safety of patients, students, staff, community, and the world as a whole. According to the World Health Organization (WHO), health care-associated infections lead to "excess deaths" and directly cause 50 000 deaths in Europe per year and contribute to 135 000 deaths per year (WHO, 2009).

Hand disinfection is an important aspect of infection control since studies have shown that proper hand hygiene has reduced the spread of health care-associated infections (WHO, 2007). Hand disinfection should be performed before and after contact with a patient to avoid spreading pathogens between patients, staff, students, and visitors.

Apart from spreading communicable diseases, lack of compliance with basic infection control routines and the resulting health care-associated infections can also lead to financial losses for the clinics involved, which could in turn possibly lead to clinics being forced to declare bankruptcy and/or close down, thus potentially reducing access to care in the area. According to WHO, roughly five million estimated annual health care-associated infections in Europe led to an analogous yearly financial loss of €13-24 billion (WHO, 2009).

The Ruminant Medicine and Veterinary Epidemiology Clinic (or the IME clinic as it will henceforth be referred to in this study) is a ruminant clinic located in Uppsala, Sweden. A study was conducted as part of the clinic's first self-evaluation in accordance with 13 § of the Swedish Board of Agriculture's provisions and guidelines (SJVFS 2013:14), reference number K112 – the infection control rules for institutions within animal health care and measures against methicillin-resistant

Staphylococcus aureus (MRSA) and methicillin-resistant *Staphylococcus pseudintermedius* (MRSP).

This study will examine the compliance with basic infection control routines among staff, students, and visitors. Additionally, a list of miscellaneous areas in need of improvement (e.g., poor cleaning) will be compiled.

1.2 Health care-associated infections and infection control

Adhering to infection control protocols is an important step in avoiding health care-associated infections (Bergström *et al.*, 2012; Nakamura *et al.*, 2012). Veterinary clinics are required to have clearly outlined infection control plans in order to prevent the spread of communicable diseases.

The National Board of Health and Welfare states, in short, that health care staff must:

- Wear clothing that is used for work purposes, has short sleeves, and is changed daily (or more often if necessary)
- Wear a plastic apron or similar protection when the risk of exposure to biological material is high
- Have short nails free from nail polish, no jewellery, bandages, watches, and similar items
- Disinfect hands with alcohol or an equivalent substance before and after each health care routine
- Wear protective gloves when the risk of exposure to bodily fluids is high

(5 § SOSFS 2015:10).

Poor compliance with these routines may contribute to the spread of dangerous pathogens and the spread of antibiotic resistance. This poses a danger to patients, staff, and individuals in the surrounding environment (Holmberg, 2012). Proper hand hygiene leads to fewer cases of health care-associated infections (WHO, 2009).

Previous studies in human and veterinary health care show that compliance with basic infection control routines is often low. For example, average compliance with hand hygiene routines in human health care, according to a number of studies published 1981-2008, was 39% (WHO, 2009). A survey conducted by the National Board of Health and Welfare (2007) showed that there was room for improvement in regard to compliance with basic infection control routines in Swedish municipal health care. Regarding veterinary health care, Shea & Shaw (2012) and Smith *et al.* (2013) conducted studies in small animal clinics in the United States and found compliance with hand hygiene routines to be 21% and 27%, respectively. Anderson *et al.* (2014) examined 38 Canadian small animal clinics and found the compliance

to be 14%. According to Pittet *et al.* (2000), increased compliance to hand hygiene routines also decreases the prevalence of nosocomial infections, including MRSA.

Numerous methods of improving compliance have been tried and found to have some effect (Simon, 2014). They include education, changes in planning and facilities (Neo *et al.*, 2016), audit tools (Higgins & Hannan, 2013), group discussions, posters, training with ultraviolet lamps (Mernelius *et al.*, 2013), and combinations of several methods – such as lectures, written reminders, and financial rewards (Won *et al.*, 2004). Neo & Sagha-Zadeh (2017) concluded that a hand sanitising station with high visibility is more likely to be used, and Nicol *et al.* (2009) suggest that "exposure to vivid vicarious experience" will improve hand hygiene more effectively than simply an educational intervention.

Various methods exist to measure compliance. Bergström & Grönlund (2014), for example, used direct observation, but also looked at clinics' purchase data, such as the number of gloves and the amount of hand sanitiser (per patient). In addition, an electronic automated hand hygiene counter has been used to monitor the level of hand sanitiser used in a clinic setting (Morgan *et al.*, 2012).

Reasons for poor compliance have been found to include "insufficient supplies of hygiene products, lack of readily accessible places for cleaning, insufficient knowledge and high workload" (Bergström & Grönlund, 2014). Anderson & Weese (2016) mention skin irritation as another important barrier to compliance. Studies by both Anderson & Weese (2016) and Robin *et al.* (2017) have shown that people who have experienced zoonoses have higher compliance with infection control routines.

According to Pittet (2001), reasons for non-compliance in a university hospital included:

> skin irritation by hand hygiene agents, inaccessibility of hand hygiene supplies, interference with [health care worker]-patient relationship, patient needs perceived as a priority, wearing gloves, forgetfulness, the lack of knowledge of guidelines, insufficient time for hand hygiene, high workload and understaffing, and the lack of scientific information showing a definitive impact of improved hand hygiene on hospital-acquired infection rates.

1.3 The IME clinic

The IME clinic employs a staff that (on a normal day) consists of two veterinarians and four members of veterinary support staff, hosts several hundred students for practical training purposes, and treats 50-100 patients per year. The amount of time

patients spend in the clinic varies greatly, but the stay usually lasts for approximately eight days. (Lindström, L., the IME clinic, pers. comm. 2018-03-29.)

The clinic has never experienced an outbreak of MRSA to the best of their knowledge (Anon., pers. comm., 2018-02-12).

The rules outlined in 5 § in the National Board of Health and Welfare's provisions (SOSFS 2015:10) are mirrored in the clinic's infection control plan and have been adapted to the particular conditions of the clinic. For example, due to the presence of large animals, the clinic has additional routines regarding the use and cleaning of rubber boots; the recommendation is to rinse the boots with hot water after contact with each patient.

1.4 Aim

The aim of this study is to examine the compliance with basic infection control routines at the IME clinic as a part of their self-evaluation in accordance with 13 § the Swedish Board of Agriculture's provisions and guidelines (SJVFS 2013:14), reference number K112, and to note miscellaneous aspects of the clinic that may need to be improved regarding infection control.

1.5 Research questions

The research questions that this study attempts to answer are:

- How well do staff, students, and visitors in the IME clinic comply with selected basic infection control routines?
- Are there other areas/aspects of the IME clinic that need improvement?

2 Materials and methods

2.1 Observations

An observational study was conducted between February 16, 2018 and March 7, 2018 in the IME clinic in Uppsala, Sweden. All observations were made during weekdays between 07.00 and 16.00 for a combined total of approximately 200 hours. The observations were made under the guise that the observers were making general measurements in the clinic and an e-mail (Appendix 1) was sent to the staff informing them of the observers' subsequent presence in the clinic over the next few weeks.

Disinfection times were measured with stopwatches on mobile phones for high accuracy.

Inclusion criteria: All available staff members and as many students and visitors as possible. Visitors included teachers from the Swedish University of Agricultural Sciences, as well as any other individual who passed the infection control barrier and who was not a student or a staff member.

2.2 Infection control barriers

The IME clinic has two types of barriers (Figure 1):

- Type 1 refers to the entrances to the clinic and requires only change of footwear and hand disinfection. There are two barriers of type 1 – one is for staff, the other (Figure 2) for students and visitors.
- Type 2 refers to the entrances to the examination rooms and requires change of footwear and hand disinfection. If one intends to have contact with a patient, it also requires the use of a rubber apron (or other protective gear such as a cotton coat), gloves, bare forearms, and (after contact with each patient) the cleaning of boots by rinsing them with hot water. There are four barriers of type 2, leading

to the examination rooms. They are used mainly by staff, a few visitors, and certain students that train at the clinic (henceforth referred to as "IME students" to distinguish them from other students, who were seen passing only through barrier type 1).

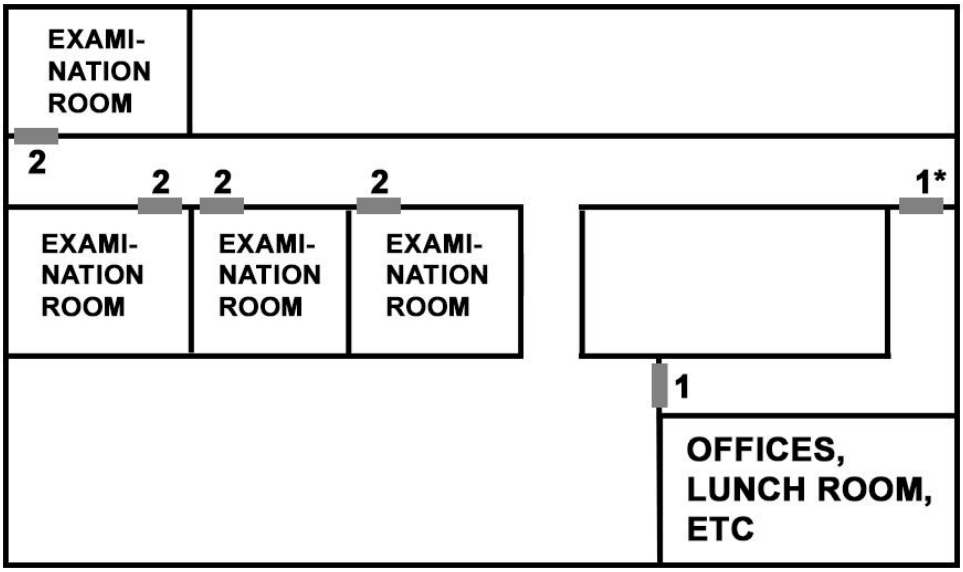

Figure 1. Simplified drawing of the IME clinic and the placements of its two different types of infection control barriers. 1 = barrier type 1 for staff. 1* = barrier type 1 for students/visitors. 2 = barrier type 2.

Figure 2. Overview of the student/visitor barrier (barrier type 1). (Photo: Josefine Stenudd)

2.3 Data processing

Microsoft Excel was used to compile the data and to calculate the results. Vassarstats.net was used to calculate the 95% confidence interval.

2.4 Protocols

The two protocols (Appendices 2-3) were based on the IME clinic's infection control plan (the IME clinic, 2015) and on a protocol used in a similar study by Novotny (2017). These, in turn, were based on 5 § in the National Board of Health and Welfare's provisions (SOSFS 2015:10) and measurements outlined by the Swedish Association of Local Authorities and Regions (2016). Additionally, the clinic's infection control plan has special recommendations regarding the changing and cleaning of footwear (the IME clinic, 2015) and these parameters were included in the protocols.

The protocols contain several of the routines from the clinic's infection control plan, including hand disinfection for 30 seconds and the change of shoes when entering and exiting the barriers; and that one is to wear gloves, rubber aprons, clean work clothes, have bare forearms, and wear one's hair up or short when one is to have direct patient contact.

The number of individuals observed in each category with each protocol:

2.4.1 Protocol 1:

- 10 staff members
- 13 IME students
- 30 miscellaneous veterinary students
- 69 veterinary nursing students
- 52 visitors

2.4.2 Protocol 2:

- 10 staff members
- 20 IME students
- 3 visitors

3 Results

3.1 Observational study

3.1.1 Staff

10 staff members were observed at barrier type 1 (see Table 1). Upon entry through these barriers, the 10 individuals had a total of 59 opportunities to disinfect their hands, giving a compliance of 24%. This was the routine with the lowest compliance. When exiting, compliance was 31% (19/61) for hand disinfection. One staff member had an overall compliance of 0% (0/2; the routines in question were hand disinfection and change of footwear, both when exiting the barrier).

Table 1. *Staff members' compliance with infection control routines at infection control barrier type 1. Hd = hand disinfection, CI = confidence interval*

	Hd upon entering (%)	95% CI	Hd upon exiting (%)	95% CI
Person 1	0	0-66	50	9-91
Person 2	50	15-85	100	51-100
Person 3	100	51-100	25	5-70
Person 4	50	24-76	22	6-55
Person 5	No data	No data	0	0-79
Person 6	0	0-32	14	3-51
Person 7	33	6-79	33	6-79
Person 8	0	0-39	33	10-70
Person 9	13	4-36	33	15-58
Person 10	0	0-39	20	6-51

Eight staff members were observed at barrier type 2 (see Table 2). Compliance with "Hand disinfection before patient contact" was 53% (10/19). After patient contact, hand disinfection compliance was 77% (20/26). Before contact with patients, 0% disinfected their hands for 30 seconds (0/17; this was the only routine with 0% compliance). Compliance with this routine after patient contact was 4% (1/25). Glove use had a compliance of 65% (15/23). The staff member with the lowest overall compliance had 38% (3/8).

Table 2. *Staff members' compliance with infection control routines at infection control barrier type 2. Hd = hand disinfection, CI = confidence interval, N/A = not applicable*

	Hd before patient contact (%)	95% CI	Hd after patient contact (%)	95% CI	Glove use (%)	95% CI	Rubber apron/protective gear (%)	95% CI
Person 1	No data	No data	100	21-100	0	0-79	0	0-79
Person 2	0	0-66	100	34-100	100	34-100	100	34-100
Person 3	100	21-100	0	0-79	100	21-100	100	21-100
Person 4	25	5-70	75	41-93	86	49-97	100	68-100
Person 7	67	21-94	100	34-100	0	0-56	67	21-94
Person 8	71	36-92	75	41-93	57	25-84	100	70-100
Person 9	100	21-100	100	34-100	N/A	N/A	50	9-91
Person 10	0	0-79	50	9-91	100	34-100	67	21-94

3.1.2 IME students, veterinary students not involved with the IME clinic, and veterinary nursing students

13 IME students were observed at barrier type 1 (see Table 3). The 13 individuals had a total of 75 opportunities to comply with the routines and did so in 26 instances (35%). Upon entry through the barrier, 23% (3/13) of the IME students disinfected their hands and 33% (4/12) did so upon exiting. 0% (0/25) of the students were observed to work the disinfectant into their hands for 30 seconds (before or after patient contact), giving these two routines the lowest compliance. 67% (8/12) changed footwear upon exiting.

20 IME students were observed at barrier type 2 (see Table 4). These 20 students had a total of 171 opportunities to comply with the routines and did so in 128 instances (75%). Compliance with "Hand disinfection before patient contact" was 79% (11/14). After patient contact, hand disinfection compliance was 65% (11/17). 0% disinfected their hands for 30 seconds before or after patient contact (0/29), meaning these two routines had the lowest compliance.

30 veterinary students not involved with the IME clinic were observed at barrier type 1 (see Table 3). The 30 students had a total of 178 opportunities to comply with the routines and did so in 82 instances (46%). Upon entry through the barrier, 57% (17/30) of these students disinfected their hands and upon exiting 47% (14/30) did so. 0% (0/60) worked the disinfectant into their hands for 30 seconds when entering or exiting, giving these two routines the lowest compliance.

69 veterinary nursing students were observed at barrier type 1 (see Table 3). The 69 students had a total of 396 opportunities to comply with the routines and did so in 184 instances (46%). Upon entry through the barrier, 41% (28/69) of these students disinfected their hands and upon exiting, 33% (20/60) did so. 0% (0/129) worked the disinfectant into their hands for 30 seconds upon entry or exit, giving these two routines the lowest compliance.

Table 3. *Compliance of IME students, veterinary students not involved with the IME clinic, and veterinary nursing students with infection control routines at infection control barrier type 1. Hd = hand disinfection, CI = confidence interval*

Action	Hd upon entering (%)	95% CI	Hd upon exiting (%)	95% CI	Change of footwear upon entering (%)	95% CI	Change of footwear upon exiting (%)	95% CI
IME students	23	8-50	33	14-61	85	58-96	67	39-86
Vet. students	57	39-73	47	30-64	90	74-96	86	69-95
Vet. nursing students	41	30-52	33	23-46	99	92-100	99	92-100

Table 4. *IME students' compliance with infection control routines at infection control barrier type 2. Hd = hand disinfection, CI = confidence interval*

Action	Hd before patient contact (%)	95% CI	Hd after patient contact (%)	95% CI	Boot cleaning (%)	95% CI
	79	52-92	65	41-83	89	69-97

3.1.3 Visitors

52 visitors were observed at barrier type 1 (see Table 5). The 52 individuals had a total of 301 opportunities to comply with the routines and did so in 105 instances (35%). Upon entry through the barrier, 10% (5/52) disinfected their hands and upon exiting 16% (8/49) did so. 0% (0/52) worked the disinfectant into their hands for 30 seconds when entering (making this the routine with the lowest compliance), but 4% (2/48) were found to comply with this routine on their way out.

Table 5. *Visitors' compliance with infection control routines at infection control barrier type 1. Hd = hand disinfection, CI = confidence interval*

Action	Hd upon entering (%)	95% CI	Hd upon exiting (%)	95% CI	Change of footwear upon entering (%)	95% CI	Change of footwear upon exiting (%)	95% CI
	10	4-21	16	9-29	92	82-97	88	76-94

Three visitors were observed at barrier type 2. They had a total of 30 opportunities to comply with the routines and did so in 24 instances (80%). Compliance with "Hand disinfection before patient contact" was 100% (3/3). After patient contact, hand disinfection compliance was 67% (2/3). Before contact with patients, 0% disinfected their hands for 30 seconds (0/3), meaning this was the routine with the lowest compliance. Compliance with this routine after patient contact was 33% (1/3).

3.2 Compliance at barrier types 1 and 2

At barrier type 1, all of the groups were observed: staff, IME students, veterinary nursing students, veterinary students not involved with the IME clinic, and visitors. Veterinary students not involved with the IME clinic showed the clearest tendency to disinfect their hands when passing in or out of the clinic through the barrier (57% and 47%, respectively), while visitors showed the lowest compliance with these routines (10% and 16%, respectively). Compliance with hand disinfection both on the way in and on the way out for all of the groups together was 30%. All of the groups were more inclined to change footwear when passing in and out, particularly the veterinary nursing students (99% both ways), while IME students showed the lowest compliance (85% and 67%, respectively).

The groups observed at barrier type 2 were staff, IME students, and visitors. All of the observed visitors complied fully with the following routines: hand disinfection before patient contact; glove use; use of rubber aprons or protective gear; clean work clothes; bare forearms; boot cleaning; and having their hair up or short. IME students complied completely with the routines regarding protective gear and hair, but showed the lowest compliance with hand disinfection after patient contact (65%), and all three groups were observed wearing clean work clothes. Staff showed the lowest compliance with a number of routines: hand disinfection before patient contact (53%); glove use (65%); protective gear (86%); bare forearms (78%); boot cleaning (78%); and hair up or short (97%). However, staff members were the most compliant group regarding hand disinfection after patient contact (77%). Compliance with hand disinfection both before and after patient contact for all of the groups combined was 70%.

3.3 Miscellaneous areas that may need improvement

3.3.1 Hand hygiene

One person touched the inside of the manure chute without gloves in order to find out why it was not working properly. They proceeded to dry off their hands on their clothes and to touch door handles without washing or disinfecting their hands first. One of the staff members was observed wearing a plaster on their finger and had several small, uncovered wounds on their hand. Another staff member was seen pouring a handful of salve onto one hand, then walking to the cows and spreading it one by one on each wound on each cow without changing gloves between each animal. One IME student was seen wearing a watch, while another wore a watch and a ring. After their lesson, a staff member alerted them to this mistake. Most of the time, the items were covered by rubber aprons and gloves, respectively.

Lastly, hand disinfectant ran out at the student barrier and it took at least 32 hours to change it.

3.3.2 Footwear

Dirt could be seen on the shoe shelf that is deemed by the clinic as the “clean side” from which one retrieves shoes to be worn into the clinic (Figure 3h). Stains could also be found on some of the shoes themselves. Neither the shelves nor the shoes were noted to have been cleaned during the roughly three week long observational

period. Additionally, individuals were often forced to walk around with socks on the inside of the barriers while looking for shoes of the right size.

Disposable shoe covers were used by a few visitors and then discarded on the shoe shelf outside of the staff barrier. The covers were dirty, broken, and looked as if they may have been used several times. (Figure 3f-g.)

A brown smear was observed on the bench in the student/visitor barrier for several days (Figure 3a). This was followed by clearly visible contamination with blood and an examination glove during the same period (Figure 3b-c). Several passersby either sat or stood on the contaminated bench while changing shoes or reaching over to retrieve shoes of correct size. Moreover, the threshold and door of the student/visitor infection control barrier were visibly dirty (Figure 3d).

One of the staff members complained that one must walk through most of the building to get to the waste disposal. The individual spoke of an incident when someone carried a waste bag, which was dripping blood from an operation, several hundred metres to the waste department without noticing. This was later cleaned up; however, during the span of time that the individual was in the waste department, passersby may have been exposed to the bodily fluids.

When the staff, students, and visitors exited the examination rooms, they rinsed their boots, stepped back down into the dirty puddles in the rooms (Figure 3e), and walked out. The staff members left the boots outside of the examination rooms, but the students often simply walked out to the student/visitor barrier while wearing their still soiled boots.

The peroxygenic acid bath (Virkon, a multi-purpose disinfectant) for disinfection of boots was supposed to be changed once a week according to a sign posted nearby. Each change was noted on the sign, which showed that the changes occasionally (at least between April 25 and February 19) had occurred less frequently than once a week, even during the months when students (who should use the boot bath after every visit) could have been presumed to have been present.

3.3.3 Rubber aprons

According to the clinic's infection control plan, the work clothes should be washed in 60 degrees Celsius, but the clinic washes the protective rubber aprons at only 40 degrees. The reason for this is that the material does not tolerate temperatures as high as 60 degrees. However, in cases of known or suspected outbreaks such as ringworm, the clinic attempts to compensate for the lower washing machine temperature, either by bathing the aprons in peroxygenic acid for 10 minutes before washing or by adding peroxygenic acid to the washing machine.

A staff member cleaned out the stall of a patient who had been euthanized. The individual used the patient-bound protective rubber apron, but did not take the apron to the laundry afterwards.

3.3.4 Straw

When the examination rooms were rinsed, puddles formed and wetted the straw in the animal stalls. Most of the excess water was scraped into the floor drain with a rubber scraper, but some remained (Figure 3e).

Figure 3. a) Bench with brown smear. b) Bench with blood stains. c) Bench with blood stain and used examination glove. d) Threshold of door in student/visitor entrance. e) Puddle formed during boot cleaning in examination room. f-g) Broken and contaminated disposable shoe covers in staff entrance. h) Shoe shelf in student/visitor entrance. (Photos: Vera Pohja and Josefine Stenudd)

4 Discussion

4.1 The infection control plan

In general, the infection control plan (the IME clinic, 2015) corresponded well with the recommendations outlined in 5 § SOSFS 2015:10.

4.2 Infection control routines in general

In light of previous studies that show low compliance with at least hand hygiene in human and veterinary health care (WHO, 2009; the National Board of Health and Welfare, 2007; Shea & Shaw, 2012; Smith *et al.*, 2013; Anderson *et al.*, 2014), the generally low compliance observed at the IME clinic may not be surprising.

Individuals with experience of zoonoses are more likely to comply with infection control routines (Anderson & Weese 2016; Robin *et al.* 2017), as mentioned, the clinic has never experienced a known MRSA outbreak, so this may be one reason for the low compliance. Perhaps the staff members felt that their current level of compliance "had worked so far" and therefore did not need to change. However, as Karlberg (2017) points out, the above studies were conducted in Canada and Great Britain, where attitudes towards and risks of zoonoses may be different from those in Sweden.

Moreover, as the results showed, the level of compliance concerning most routines requires serious improvement with respect to staff, students, and visitors.

4.3 Hand disinfection

Proper hand disinfection had the lowest compliance in each group. As Pittet (2001) discovered as reasons for non-compliance in a university hospital, this may have been because of forgetfulness, "lack of knowledge of guidelines, and the lack of

scientific information showing a definitive impact of improved hand hygiene on hospital-acquired infection rates" (Pittet, 2001). Poor resources, being too busy, and hand disinfection causing an unpleasant feeling on one's hands have been cited as the reasons for low compliance in another study of veterinary support staff (Nakamura *et al.*, 2012). However, "being too busy" was most likely not a deciding factor for compliance levels of the staff during the observational period because of a low patient flow and a low frequency of staff-patient interaction.

The veterinary nursing students who were observed passing barrier type 1 were going to and from a practical exam, which may have affected their stress levels, especially when entering the clinic.

In some cases when a large group of individuals came, everyone followed the example of the first person passing through the barrier, i.e., if the first person in the group disinfected their hands, then the rest of the group seemed more likely to do so as well and vice versa. In addition, a leading individual in a large group of visitors once loudly exclaimed that since they would not be touching anything, they would not need to disinfect their hands, which led to the rest of the group agreeing and deciding to not use the provided hand disinfectant. The above events may have been due to peer pressure.

In three instances out of 45, it was unknown whether a staff member who disinfected their hands at barrier type 2 did so for the recommended 30 seconds, so it is possible that compliance with this routine was somewhat higher than 0%. In two instances, it was unknown whether an IME student who disinfected their hands at this barrier type did so for 30 seconds, and so compliance with the routine may have been somewhat higher than 0% here as well. Finally, it should be noted that when entering barrier type 1, no visitor disappeared from view before they had finished disinfecting their hands. When exiting the barrier, only one visitor was out of observational range before the recommended 30 seconds had passed, and so it is unknown whether this person followed the routine.

It has been noted that before crossing the infection control barriers, individuals may have disinfected their hands at a previous barrier. However, all routines in infection control barriers should be followed. There are several door handles in the building that may have been used, so to reach one of the barriers, one may have touched contaminated surfaces on the way to the next one. There are no exceptions mentioned in the infection control plan.

Considering how long it took to replace the aforementioned empty container of hand disinfectant at the student barrier, the clinic should appoint someone in the staff to be responsible for making sure the containers of disinfectant do not run out (if such a person has not already been appointed).

4.4 Glove use

According to the clinic's infection control plan, one is to wear gloves when coming into direct contact with patients. This seems to be a reasonable requirement, as glove use reduces the need for handwashing. The latter can lead to skin irritation and other problems if performed too frequently (Kampf & Kramer, 2004).

Glove use had a very high compliance rate when it came to the veterinary students, but relatively low when it came to the staff. The reason for this could be because the veterinary students were being observed by the head of the clinic as they were performing their practical tasks. The reasons most often cited by Nakamura *et al.* (2012) for lack of hand hygiene were stress and feeling rushed. According to an interview study by Widegren (2017), some of the reasons most often cited for failing to use gloves were stress, carelessness, difficulty in putting on gloves after disinfecting hands, the placement of the glove container, emergencies, and difficulty in dropping old habits. According to Karlsson (2016), the main reasons for non-compliance were a lessened sense of control (presumably meaning a reduced sense of touch), bad habits, time constraints, ignorance, and because "some tasks did not require gloves."

The clinic had a low patient flow and infrequent staff-patient interaction, so the lack of adherence to infection control protocols was most likely not caused by stress; bad habits would seem a more likely reason. As mentioned, the staff may have been lulled into a false sense of security due to never having experienced an outbreak of MRSA.

4.5 Change of footwear

Change of shoes when entering and exiting the barriers had a relatively high compliance rate, possibly because the students and visitors most likely did not want to soil their own everyday shoes while they were inside the barriers. There is also a significant border in the form of a bench that one needs to step over in order to get to the "clean" side. It is obvious to others whether or not one has changed shoes, which may make it more likely that individuals will decide to change shoes in order to be seen as compliant with infection control routines (Bergström & Grönlund, 2014). One staff member complained about the need to change footwear. It is somewhat surprising that the compliance with change of footwear is higher than hand disinfection, since the latter could be considered less of a "hassle".

4.6 Boot cleaning

While compliance with the clinic's own recommendations (rinsing boots with hot water after each patient) was generally high, this routine may not be sufficient in controlling the spread of infection; Amass *et al*. (2000) found that boots should be scrubbed clean of manure, then soaked in a clean disinfectant bath for sufficient time (depending on the type of disinfectant) in order to achieve satisfactory disinfection.

When boot cleaning was not performed, it may have been because the subject felt it was futile – they may have been familiar with the correct cleaning method outlined above, and/or they may simply have observed the fact that the boots would become re-contaminated when stepping back into the dirty puddles on the floor. It is conceivable that laziness or carelessness contributed to non-compliance with this routine as well.

4.7 Clothing and protective gear

Use of correct and clean work clothes including a rubber apron/protective gear, having hair up/short, and having bare forearms had the highest compliance, most likely because of the fact that it is clear to others whether or not proper attire is worn and because it takes minimal effort (Bergström & Grönlund, 2014). As previously mentioned, however, there were a few incidences of noncompliance regarding these routines. For example, only one individual (a staff member) was seen with loose hair, which reached down to their shoulders.

4.8 On the methods

The date was noted on each protocol in order to avoid making all observations of any one person in only one or two days; for example, if a person was observed only on one particularly busy day, their compliance may have been low due to stress. This may bias the results towards low overall compliance for that person. However, on most days there was relatively little activity; therefore one person was sometimes observed more than once per day for each protocol, not least because the opportunities for observation were few.

Each staff member was observed as many times as possible, as they were few in number. The identity was noted on each observation, as some individuals were observed more times than others.

It should be noted that while attempts were made to observe staff members' compliance with "30 seconds of hand disinfection upon entering/exiting" at barrier type

1, this routine was ultimately excluded from the study. If a staff member passed barrier type 1 and applied hand disinfectant for the 30 seconds recommended by the IME clinic (2015), they were frequently out of observation range by the time the 30 seconds had passed. Thus, there may have been several instances when this rule was followed, yet could not be recorded by the observer.

While it is important to apply a liberal amount of hand disinfectant (a "palmful" is recommended by WHO [2009]), this routine was not included in the protocol as it was often difficult to judge the amount of hand disinfectant used by the subjects, since their backs were often turned to the observer.

The infection control plan (the IME clinic, 2015) recommends that one wears gloves at all times while handling patients in the IME clinic. The alternative would be to wash one's hands between each patient; however, frequent washing might damage one's skin (Kampf & Kramer, 2004).

The parameters chosen for the protocols were based not only on their importance for good infection control, but also on whether they could realistically be observed without revealing the purpose of the study. For instance, the amount of hand disinfectant used each time was not observed, since it would have been obvious to the subjects that they were being monitored for their compliance with infection control routines.

For the purpose of the observations, a veterinarian and the veterinary support staff were counted in one category, as there were only two veterinarians and one of them was familiar with the purpose of the observations (this latter person was not included in the statistical analysis). However, staff, students, and visitors were counted as separate categories.

The students were numerous and most were observed only once. In the cases where a student had been observed multiple times, one of their protocols (selected at random in order to avoid bias) was included in the results to avoid counting the same person more than once. It would have been difficult to observe any given student as many times as each staff member, partly because students made only a few visits and partly because they were often difficult to identify individually when they first appeared. It was more practical to identify them after the observations. This approach led to some students being observed more than once.

The visitors passing through barrier type 2 were the smallest group, consisting of only three individuals who all appeared together. Several of the routines were performed by all three. The possible peer pressure mentioned above may have contributed to this.

Video surveillance as an observation method was decided against, as its use is complicated by legal and ethical concerns (Johansson, T., SLU, pers. comm. 2018-02-14). It may have been more accurate and efficient than direct observation, considering that the "Hawthorne effect" (i.e., the tendency of a person to behave better

when they know someone is watching them [Hagel *et al.*, 2015]) might temporarily enhance compliance during observation.

The number of observations was limited because of low patient flow, very limited interaction between patients and staff, and because several staff members were on sick leave or retired part-time.

Most of the subjects under observation were aware that they were being observed and at least some of them speculated about the purpose of the study. Even if these factors caused the aforementioned Hawthorne effect to come into play, it should be noted that compliance with infection control routines was still unsatisfactory, and in some cases non-existent. For example, no staff member was found to have a perfect overall level of compliance. In the absence of observers (i.e., without the Hawthorne effect), it is possible that compliance at the IME clinic would be even lower.

Because of the infrequent interaction between patients and staff, the scope of this study did not allow for a very large number of observations, although this would have been desirable for reasons of statistical accuracy.

This study will hopefully give some indication of the quality of infection control in the IME clinic, especially considering that it was their first self-evaluation. In other words, it is likely that members of the clinic have gained some new knowledge and now have a better idea of their strengths and weaknesses in terms of infection control, and consequently may allocate their resources to alleviate the most urgent problems. Furthermore, the study may be of use to similar clinics elsewhere.

4.9 Suggestions for improving compliance

Considering that compliance was less than perfect, it may be advisable to use some or all of the previously mentioned methods that have been shown to improve compliance, and the miscellaneous problem areas previously mentioned should also be rectified.

Which particular methods should be chosen may depend on what is most practical for the clinic in question – for example, one may need to consider the layout of the building, which routines are most in need of improvement, and how affordable the measures are (although an expensive but effective measure may "pay off" in the long term by preventing expensive disease outbreaks).

Hand sanitising stations should be clearly visible, in accordance with the findings of Neo & Sagha-Zadeh (2017).

The clinic could hold staff meetings or promote educational interventions to ensure that every individual understands the routines for infection control and the po-

tential consequences of non-compliance. Studies have shown that continued and focused educational interventions have improved adherence to infection control protocols (Simon, 2014; Mernelius *et al.*, 2013).

One might use some of the compliance measuring methods mentioned by Bergström & Grönlund (2014) in order to hold contests among different clinics. For example, the clinic using the largest amount of hand sanitiser (per patient) in a given period wins and the staff members are rewarded. This may encourage compliance in clinics. However, this method of measurement comes with the aforementioned risk of deception.

Conversely, one may also implement a form of reprimand if routines are not followed, i.e., pay cuts or redistributing the employee within the organization.

The "vivid experiences", which according to Nicol *et al*. (2009) can enhance compliance, could be put to use. Examples might include graphic images or videos of the consequences of nosocomial infections, perhaps even visits and moving lectures by individuals who have survived life-threatening infections or who have lost friends (human or non-human) to such infections. Visitors from clinics that have been severely affected or have closed down because of outbreaks of MRSA and other diseases may also have an impact.

It may be advisable to post larger and more eye-catching signs in the infection control barriers reminding staff and visitors to change their shoes and disinfect their hands (Figure 4). Additionally, signs should explain how to properly disinfect one's hands for the 30 seconds recommended by the IME clinic (2015). Furthermore, the clinic could implement more ways to remind people that it is an infection control barrier and that certain steps need to be taken in order to pass through. For example, the clinic could have dimmer lighting in the barrier, walls coloured in a striking hue, or they could install the aforementioned electronic hand hygiene counting device (Morgan *et al.*, 2012).

As previously mentioned, the clinic should assign someone to be in charge of infection control (if they do not already). This person's duties should include ensuring that the routines are followed, that the infection control plan is kept updated, and that everyone understands the importance of compliance.

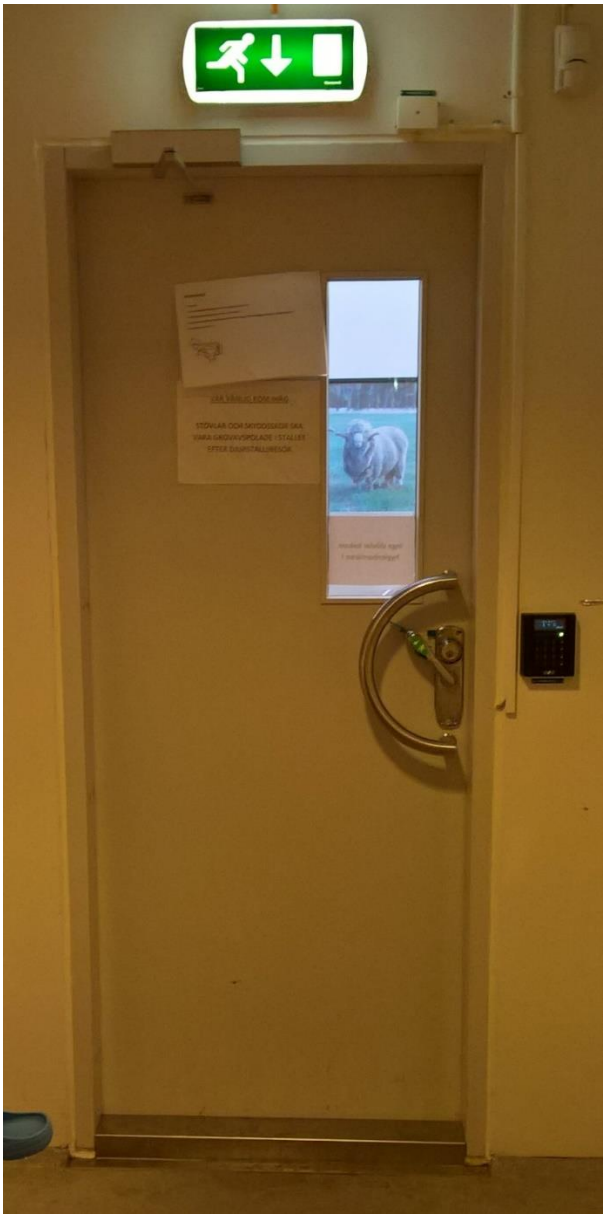

Figure 4. Small instruction signs on door at the student/visitor barrier (barrier type 1). (Photo: Vera Pohja)

Nettle *et al.* (2012) found that signage depicting eyes (giving the illusion that people in these areas were being watched) decreased the incidence of bicycle theft, which can be seen as increased compliance; similar signage may contribute to increasing compliance with infection control routines. It is a cheap and simple method worth trying. Moreover, it would be interesting to study whether compliance is affected by knowledge of the purpose of such signage.

As has been mentioned, in one instance, a staff member failed to take a patient-bound rubber apron to the laundry after the patient had been euthanized. This was a violation of the infection control plan (the IME clinic, 2015). The apron was left in the examination room, where it may later have been presumed to be clean when the next patient arrived.

The plaster which one staff member was seen wearing on their hand is not acceptable according to the guidelines of 5 § SOSFS 2015:10, on which the clinic's infection control plan (the IME clinic, 2015) is based. The small wounds on the individual's hand were a potential problem as well. They should have worn gloves to prevent the spread of pathogens. Similarly, the watches and the ring worn by two IME students were an obvious violation of the infection control plan (the IME clinic, 2015), which states that watches, rings, and similar items should not be worn.

Additionally, the clinic could consider installing doors that can be opened without being forced to touch the door handles. For example, they could consider installing foot operated door openers or motion sensor door openers.

The threshold and door of the student/visitor infection control barrier may need to be cleaned more often (Figure 3d). Both the shoes and the shelves they were stacked on (Figure 3h) should be cleaned regularly. Considering that some passersby sat and/or stood on the soiled bench (Figure 3a) in the student barrier, cleaning routines should be amended so that the surfaces of the clinic are cleaned on a more regular basis, as the contamination by bodily fluids could lead to a contagion. For similar reasons, it would be advantageous if the infection control barriers of type 1 were remodelled in such a way that individuals would not need to walk with socks on the inside of the barrier in order to reach suitable shoes. Furthermore, instead of wearing their boots when walking from the examination rooms to the first infection control barrier, the IME students should have brought the supplied shoes with them to the examination rooms and changed into the shoes when they were leaving the examination rooms. The boots should then have been carried back to the peroxygenic acid bath to be disinfected.

Disposable shoe covers were used by a few visitors and then discarded on the shoe shelf outside of the staff barrier. There should have been a waste bin for the shoe covers that were now discarded on a shoe shelf. (Figure 3f-g.) Moreover, whether the covers had been used multiple times or not, they had been used on the inside of the barrier and should not have come into contact with the shoes intended for use on the outside. Also, the boot cleaning system may need to be improved so that one would not need to step back into dirty puddles after rinsing one's boots.

These puddles often soak the straw in the examination rooms as well, which could cause the growth of mould. It should be noted that some staff members complained about the faulty construction of the floor that causes this poor runoff.

4.10 On future studies

Future studies could potentially include the investigation of other routines, make a larger number of observations (thereby getting even more reliable results), compare the IME clinic with similar clinics elsewhere, examine the results of educational interventions (in the short or long term), or use a different method of observation. The IME clinic may wish to compare this first self-evaluation with future ones. Although Hagel *et al*. (2015) found that the Hawthorne effect increases compliance, it may be possible to discern trends over time, assuming a "constant Hawthorne effect" (which would undoubtedly be difficult to determine). However, comparisons may be affected by changes of staff, as well as by the fact that the purpose of the study was to be revealed to the current staff after the first evaluation.

As previously mentioned, one may also examine the number of gloves and the amount of hand disinfectant used per patient over time (as suggested by Bergström & Grönlund, 2014). This can be done with or without the knowledge of the staff. An advantage would be that these methods are simple and may be perceived as less invasive than observations. However, since individual compliance is not measured, it may be possible for some individuals to use as much (or little) material as before (thereby remaining a "weak spot" in the infection control), while others may increase their use and thus increase the amount per patient. Another disadvantage is the possibility of cheating, i.e., if glove use is measured, staff may purposely dispose of unused gloves or use an excessive number of them in order to appear to have used more.

Overall, considering how low compliance is to hygiene routines around the world, it is evident that more studies need to be made and drastic changes need to be made within the field to ensure a safe work environment. This study will hopefully contribute to the betterment of hygiene routines around the world, starting with the ruminant clinic in question, and similar studies should be conducted in other clinics.

5 Conclusion

The results of this study confirm that there is room for improvement when it comes to the adherence to infection control routines within the IME clinic. The areas that are most lacking include proper hand disinfection when passing through the infection control barriers. In addition, there are several areas and aspects of the building that require improvement, especially concerning the layout of the infection control barriers and the routines in place for cleaning various surfaces.

Routines which at present appear to have relatively high compliance include changing footwear, using protective gear, wearing clean work clothes, and having one's hair tied up or short.

Additional studies involving more observations of a larger number of individuals would need to be performed in order to achieve even more accurate results of the compliance with infection control routines; however, one can clearly see that certain aspects, including proper hand infection control routines require significant improvement.

This study offers the IME clinic an important step in their mission to improve their overall adherence to their infection control plan, which in turn leads to a safer environment for the staff, students, visitors, patients, owners of the patients, the community, and the world as a whole.

6 Anonymisation

In order to remain anonymous, the names of all subjects were randomly changed to numerical codes using the random number generator random.org.

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Figure 5. Calf and cow with no known association to the IME clinic. (Photo: Josefine Stenudd)

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Appendix 1

The following "scenario" was e-mailed to the staff members:

"Hello everyone,
2 students working on their thesis (Vera and Josefine) will be present in Building 3 during weeks 7-8-9 and possibly somewhat later to conduct measurements. It would be good if everyone were to wear nametags in order to facilitate their work. They need to see which people are students and which people work here.
We will hear about the subject of the project further on, when the measurements are finished, in order not to affect the result.
[Name]: can you spread the info to [name] and [name].
Regards
/Lina"

In Swedish:

"Hej alla,
2 examensarbetare (Vera och Josefine) kommer att röra sig i hus 3 under v 7-8-9 och ev ngt senare och göra mätningar. Det bra [sic] om alla har namnskylt på sig för att underlätta deras arbete. De behöver kunna se vilka som är studenter och vilka som jobbar här.
Vi kommer att få höra vad projektet handlar om längre fram, när mätningen är avslutad, för att inte påverka resultatet.
[Namn]: kan du sprida info till [namn] och [namn].
Vänliga hälsningar
/Lina"

Appendix 2

Protocol 1

□ Staff
□ Student
□ Visitor

□ Staff entrance
□ Student entrance

Date: _____
ID: _____

Hand disinfection upon entering?	□ Yes	□ No
Applied for at least 30 s?	□ Yes	□ No
Hand disinfection upon exiting?	□ Yes	□ No
Applied for at least 30 s?	□ Yes	□ No
Change of footwear upon entering?	□ Yes	□ No
Change of footwear upon exiting?	□ Yes	□ No

Hand disinfection: Hand disinfectant should be applied for 30 seconds before and after entering or exiting

Appendix 3

Protocol 2

□ Staff

□ Student

□ Visitor

Date: _____

ID: _____

Hand disinfection before contact with patient?	□ Yes	□ No	
Applied for at least 30 s?	□ Yes	□ No	
Hand disinfection after contact with patient?	□ Yes	□ No	
Applied for at least 30 s?	□ Yes	□ No	
Correct use of gloves	□ Yes	□ No	□ Not applicable
Rubber apron/protective gear?	□ Yes	□ No	
Clean work clothes at beginning of procedure?	□ Yes	□ No	
Forearms bare?	□ Yes	□ No	Comment: _____
Correct boot cleaning?	□ Yes	□ No	Comment: _____
Hair tied up or short?	□ Yes	□ No	

Hand disinfection: Hand disinfectant should be applied for 30 seconds before and after each patient

Proper work clothes: Sleeves above elbows, correct clothing for the work to be done

Forearms bare: No watches, bracelets, rings, bandages, fake nails. Additionally, nails should be short

Gloves: To be used if there is risk of one's hands getting in contact with bodily fluids

Rubber apron/protective gear: During procedures that include risk of contact with bodily fluids or other biological material. Patient-specific. Should be changed when soiled or when patient leaves.
Clean work clothes: Clothes that are free from visible stains (bodily fluids, food stains, etc.)
Correct boot cleaning: Boots should be submerged in Virkon [peroxygenic acid] for 10 minutes in between patients or hosed off with hot water
Hair: Should be cut short or tied up so that it is out of the way